Appendix 15-A Preapproved Proprietary Wall and Reinforced General Design Requirements

Wall design shall be in accordance with the WSDOT Geotechnical Design Manual (GDM), the LRFD Bridge Design Manual (BDM) and the AASHTO LRFD Specifications. Where there are differences between the requirements in the WSDOT GDM and the AASHTO LRFD Specifications, this manual shall be considered to have the highest priority. Note that since a LRFD design method for reinforced slopes is currently not available, the allowable stress design method provided in **Elias, et al. (2001)** shall be used for reinforced slopes, except that geosynthetic reinforcement long-term nominal strength shall be determined in accordance with WSDOT Standard Practice T925.

It is recognized that many of the proprietary wall suppliers have not fully implemented the LRFD approach for the design of their wall system(s). The approved details for the currently preapproved proprietary wall systems included as appendices to **WSDOT GDM Chapter 15** have been developed in accordance with the AASHTO Standard Specifications for Highway Bridges (**2002**). For the preapproved proprietary wall systems provided in **WSDOT GDM Appendix 15-D**, approved on or before December 1, 2004, and have remained in approved status until the present, WSDOT will allow a grace period regarding the implementation of the LRFD approach. In those cases, the AASHTO Standard Specifications for Highway Bridges (**2002**), as modified in the **WSDOT GDM**, may be used for the design of those systems until such time that WSDOT decides to end the grace period.

The wall or reinforced slope supplier, or the supplier's consultant, performing the geotechnical design of the structure shall be performed by, or under the direct supervision of, a civil engineer licensed to perform such work in the state of Washington, who is qualified by education or experience in the technical specialty of geotechnical engineering per WAC 196-27A-020. Final designs and plan sheets produced by the wall supplier shall be certified (stamped) in accordance with the applicable RCW's and WAC's and as further specified in this manual (see **WSDOT GDM Chapters 1 and 23**).

The design calculation and working drawing submittal shall include detailed design calculations and all details, dimensions, quantities, and cross-sections necessary to construct the wall. The calculations shall include a detailed explanation of any symbols and computer programs used in the design of the walls. All computer output submitted shall be accompanied by supporting hand calculations detailing the calculation process.

The wall/reinforced slope supplier shall be responsible to design the wall for external stability (sliding, overturning, and bearing) and internal stability (structural failure of wall/reinforced slope components including the soil reinforcement, facing, and facing connectors to the reinforcement, and pullout), for all applicable limit states (as a minimum, serviceability, strength and extreme event). The wall supplier shall also be responsible to design the traffic barrier (all walls) and the distribution of the impact load into the soil reinforcement (MSE walls) in accordance with the AASHTO Standard Specifications (**2002**) for both LRFD and LFD/allowable stress design. Overall stability and compound stability as defined in the AASHTO LRFD Specifications is the responsibility of the geotechnical designer of record for the project. The geotechnical designer of record shall also provide the settlement estimate for the wall and the estimated bearing resistance available for all applicable limit states. The wall/reinforced slope supplier or the supplier's consultant shall be responsible to make sure that the structure is stable in consideration of the estimated settlement and bearing resistance. If bearing or overall stability is inadequate, or settlement too great, for the wall/reinforced slope supplier to provide an acceptable design, the geotechnical designer of record is responsible to develop a mitigation design in accordance with this manual

(**GDM**) to provide adequate bearing resistance, overall stability, and acceptable settlement magnitude to enable final design of the structure. The geotechnical designer of record shall also be responsible to provide the design properties for the wall/reinforced slope backfill, retained fill, and any other properties necessary to complete the design for the structure, and the peak ground acceleration for seismic design. Design properties shall be determined in accordance with **WSDOT GDM Chapter 5**. The geotechnical designer of record is responsible to address geologic hazards resulting from earthquakes. Mitigation for seismic hazards such as liquefaction and the resulting instability shall be done in accordance with **WSDOT GDM Chapter 6**. The geotechnical designer of record shall also provide a design to make sure that the wall/reinforced slope is adequately drained, considering ground water, infiltration from rainfall and surface runoff, and potential flooding if near a body of surface water, and considering the ability of the structure backfill material to drain.

The wall/reinforced slope shall be designed for a minimum life of 75 years, unless otherwise specified by the State. All wall/reinforced slope components shall be designed to provide the required design life.

Backfill selection shall be based on the ability of the material to drain and the drainage design developed for the wall/reinforced slope, the ability to work with and properly compact the soil in the anticipated weather conditions during backfill construction, and the susceptibility of the backfill reinforcement to damage due to placement and compaction of backfill on the soil reinforcement. Minimum requirements for backfill used in the reinforced zone of MSE walls and reinforced slopes are provided in **Table 15-A-1**. More stringent requirements will likely be necessary depending on the assessment of backfill needs as described above. This is especially likely in western Washington regarding the fines content and overall gradation; hence Gravel Borrow per the WSDOT Standard Specifications is recommended.

Sieve Size	Percent Passing
100 mm (4 in.)$^{+}$	100
0.42 mm (No. 40)	0-60
0.074 mm (No. 200)	0-15

Table 15-A-1 Minimum gradation requirements for MSE walls and reinforced slopes.

All material within the reinforced zone shall be substantially free of shale or other soft, poor durability particles, and shall not contain recycled materials, such as glass, shredded tires, portland cement concrete rubble, or asphaltic concrete rubble, nor shall it contain chemically active or contaminated soil such as slag, mining tailings, or similar material.

The corrosion criteria provided in the AASHTO LRFD Specifications for steel reinforcement in soil are applicable to soils that meet the following criteria:

- pH = 5 to 10 (AASHTO T289)
- Resistivity $\geq$ 3000 ohm-cm (AASHTO T288)
- Chlorides $\leq$ 100 ppm (AASHTO T291)
- Sulfates $\leq$ 200 ppm (AASHTO T290)
- Organic Content $\leq$ 1 percent (AASHTO T267)

If the resistivity is greater than or equal to 5000 ohm-cm, the chlorides and sulfates requirements may be waived.

For geosynthetic reinforced structures, the approved products and values of T_{al} in the Qualified Products List are applicable to soils meeting the following requirements:

- Soil pH (determined by AASHTO T289) = 4.5 to 9 for permanent applications and 3 to 10 for temporary applications.
- Maximum soil particle size ≤ 1.25 inches, unless full scale installation damage tests are conducted in accordance with WSDOT Standard Practice T925 so that the design can take into account the potential greater degree of damage.

Soils not meeting the requirements provided above shall not be used.

The design of the MSE wall (precast panel faced, and welded wire faced, with or without a precast concrete, cast-in-place concrete, or shotcrete facia placed after wall construction) shall result in a constructed wall that meets the following tolerances:

1. Deviation from the design batter and horizontal alignment, when measured along a 10 ft straight edge, shall not exceed the following:
   a. Welded wire faced structural earth wall: 2 inches
   b. Precast concrete panel and concrete block faced structural earth wall: 3/4 inch
2. Deviation from the overall design batter of the wall shall not exceed the following per 10 ft of wall height:
   a. Welded wire faced structural earth wall: 1.5 inches
   b. Precast concrete panel and concrete block faced structural earth wall: 1/2 inch
3. The maximum outward bulge of the face between welded wire faced structural earth wall reinforcement layers shall not exceed 2 inches. The maximum allowable offset in any precast concrete facing panel joint shall be 3/4 inch. The maximum allowable offset in any concrete block joint shall be 3/8 inch.

The design of the MSE wall (geosynthetic wrapped face, with or without a precast concrete, cast-in-place concrete, or shotcrete facia placed after wall construction) shall result in a constructed wall that meets the following tolerances:

Description of Criteria	Permanent Wall	Temporary Wall
Deviation from the design batter and horizontal alignment for the face when measured along a 10 ft straight edge at the midpoint of each wall layer shall not exceed:	3 inches	5 inches
Deviation from the overall design batter per 10 ft of wall height shall not exceed:	2 inches	3 inches
Maximum outward bulge of the face between backfill reinforcement layers shall not exceed:	4 inches	6 inches